Electronic government system measurement model: a systematic testing of e-government implementation

Moh Hidayat Koniyo[1,2], Ida Ayu Dwi Giriantari[2], Made Sudarma[2], Ni Made Ary Esta Dewi Wirastuti[2]
[1]Department of Informatics Engineering, Faculty of Engineering, Gorontalo State University, Gorontalo, Indonesia
[2]Doctor of Engineering Science, Faculty of Engineering, Udayana University, Bali, Indonesia

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ABSTRACT

The demands to improve electronic government systems are increasing due to the large gap in the unsuccessful implementation in government. This study aimed to develop a measurement model consisting of policy, governance, and service, resources (usage) variables with their indicators to reduce the gap. A quantitative method was used with structural equation modelling (SEM) analysis based on partial least square (PLS) variance using SmartPLS version 3.0 software. Data collection for this study involved the direct distribution of questionnaires to 320 respondents, resulting in a successful collection rate of 95.3%. Subsequently, the collected data underwent analysis using the stages of SEM techniques. The results of the study show that the developed measurement models and indicators can be used as measuring tools for the execution of e-government. The developed model exhibits a satisfactory level of predictive relevance concerning the relationships among the variables, namely policy, governance, service, and usage. Furthermore, hypothesis testing was conducted to assess the validity of the proposed hypotheses within the model.

Corresponding Author:

Moh Hidayat Koniyo
Department of Informatics Engineering, Faculty of Engineering, Gorontalo State University
Bone Bolango, Gorontalo, Indonesia
Email: hidayat_koniyo@ung.ac.id

1. INTRODUCTION

The demands for government management have become more complex since the globalization and regional autonomy era. Governments must prepare an efficient bureaucratic system by developing information technology to strengthen their institutional performance. Hence, the government developed e-government as an information technology system to improve services. This system gives internal and external parties the option to access information easily. E-government enables quick and comprehensive real-time responses to user needs [1]. Additionally, it is an example of how Information and communication technology (ICT) could enhance participation, efficiency, interoperability, and privacy [2].

The adherence of local governments and institutions to regulations, best practices, and standards plays a crucial role in the effective implementation of information technology [3]. Similarly, an incomplete analysis of the need for IT utilization could hinder effective IT development [4]. Institutional, human, process, technology, and service quality factors significantly determine the readiness for IT implementation [5]. Research findings indicate that the execution of e-government in local government is partial and not supported by the readiness of regulations and procedures. Furthermore, limitations of human resources make management systems and work processes ineffective. According to Meiyanti *et al.* [6], the implementation of e-government can be categorized into three outcomes: 35% total failure, 50% partial failure, and only 15% success. A high gap in the failure of e-government implementation is shown by Meiyanti *et al.* [6], despite heavy investments by the governments in

information system procurement to bolster internal operations and facilitate communication and transactions with external entities [7].

Monitoring and evaluation showed that the e-government implementation in several regions is suboptimal, with an average score of 2.40 in all dimensions [8]. The most fundamental cause of the less-than-optimal execution of e-government initiatives is the absence of effective strategies, frameworks, or models for use as a measurement reference. This opinion is in accordance with the research of Joshi and Islam [9] that developing countries have not yet successfully adopted an effective e-government model, which has led to the absence of a suitable strategic blueprint for implementing long-lasting e-government services. The successful implementation of e-government necessitates a comprehensive structural and procedural framework that comprises the active participation of all relevant stakeholders, organizations, and technical considerations; additionally, political and legal actions are crucial in ensuring the smooth adoption and operation of e-government initiatives [10]. Furthermore, other influencing factors are citizens and the government [11].

Several researchers have researched on the determinants of the success and downfall of e-government implementation. Research by Altameem *et al.* [12] conducted a comprehensive identification and review of various e- government implementation frameworks consisting of three factors, namely governance, technical and organizational factors. Another study, by Joia [13] conducted a G2G e- government study which concluded that there were three determining factors for the success and failure of G2G e- government, namely security, organizational culture and training. Almutairi [14] conducted research during the e-gov project in Kuwait (2002-2007) and concluded that there were two groups of crucial determinants for the accomplishment of e-government, namely personal factors and organizational factors. Furthermore, Garcia [15] examines the crucial determinants of e-government in Singapore and concludes that four groups of factors consist of managerial, technical, financial and human behavior. Meanwhile Gunawardhana and Perera [16], the factors that significantly impact the failure of information system development and implementation in e-government are grouped into organizations, human resources, technology, services, and processes. By comparing the determinants of success and failure of e-government it shows that the human factor (human resources) is seen as an important factor, but in the above studies the human resource factor is measured only in the aspects of motivation and education and training, even though the human resource factor as a user (use) is very decisive as a decision maker to correct deficiencies so that later a system can run better.

The evaluation models could be improved by integrating them into a broader framework comprising human and social change variables and adopting innovation models. The basic thing is that resource variables as users need to be used as a determinant in measuring the success of e-government. However, considering the opposite perspective or contrasting viewpoint, in accordance with the different attributes and cultures of local governments in Indonesia, components that need to be considered in evaluating e-government are policy and regulatory factors, organization, planning, ICT infrastructure, applications [17], then human resources. as a user is also a major factor in evaluating. Furthermore, the measurement of information system success is influenced by the evolving role and utilization of information technology [18]. Previous studies have used the viewpoint of the ranking dimensions to analyze the Indonesian e-government [19], [20]. In 2018, the term e-government changed to a digital government system through presidential regulation 95/2018 concerning digital government systems. The change was affected through ministerial regulation 59/2020 of Indonesia on monitoring and evaluation of digital government systems [17]. Additionally, the regulation of the minister of state apparatus utilization and bureaucratic reform of Indonesia Number 962 of 2021 was issued on technical guidelines for monitoring and evaluating electronic-based government systems [19].

This study developed a measurement model concept for evaluating the execution of e-government in local government in line with previous studies and the applicable regulations. The model developed has four dimensions, nine aspects, and fifty-seven indicators [21], as illustrated in Figure 1. Table 1 shows the measurement model indicator framework.

The developed model concept contains four hypotheses, where H1 states that the policy variable impacts governance. H2 proposed that policy influences the service variable, while H3 states governance affects the service. Additionally, H4 states the service variable impacts usage. The policy variable has only the internal policy aspect with ten indicators using a measurement level 1-stub, 2-managed, 3-defined, 4-integrated and measured, and 5-optimum. The governance variable consists of five dimensions, which encompass institutional and implementation (with two indicators), strategy and planning (with four indicators), digital technology (with four indicators), implementation of electronic government management systems (with eight indicators), and implementation of digital technology audits (with three indicators). Furthermore, this variable uses measurement levels 1-stub, 2-managed, 3-defined, 4-Integrated and measured, and 5-optimum. The service variable is comprised of two aspects: digital government administrative services (with ten indicators) and digital public services. The variable uses the level of measurement 1-information, 2-interaction, 3-transaction, 4-collaboration, and 5-optimum. The variable measures the user-friendliness of electronic-based services through thirteen indicators, using a scale ranging from 1 (very difficult) to 5 (very easy) to assess ease

of use. Table 1 shows the complete measurement indicator framework. This study aimed to determine the model and indicators that could be a measuring tool with a good predictive relevance towards the relationship between policy, governance, services, and use, as well as hypothesis testing.

Table 1. Measurement indicator framework

Variable	Aspect	Code-indicator	Measurement level
1. Policy	1. Internal policy	K1 - e-government coordination team	1. Stub
		K2 - e-government architecture	2. Managed
		K3 - Map of the e-government plan	3. Defined
		K4 - Development of e-government applications	4. Integrated and measurable
		K5 - Data center services	5. Optimum
		K6 - Intra network service	
		K7 - Use of the service liaison system	
		K8 - Data management	
		K9 - Information security management	
		K10 - ICT audits	
2. Governance	2. Institutions and implementation	T11 - Coordination team carrying out duties and work programs	1. Stub
		T12 - Implementing e-government collaboratively	2. Managed 3. Defined
	3. Strategy and planning	T13 - Have an e-government architecture	4. Integrated and measurable
		T14 - Have an e-government plan map	5. Optimum
		T15 - Integration of e-government plans and budgets	
		T16 - Implementing business process innovation	
	4. Information and communication technology (ICT)	T17 - Implementing integrative development of e-government	
		T18 - Own data center services	
		T19 - Using intra network services	
		T20 - Using the service liaison system	
	5. Implementation of electronic-based government system management	T21 - Implementing risk management	
		T22 - Implementing data management	
		T23 - Implementing information security management	
		T24 - Implementing ICT asset management	
		T25 - Implementing human resource competency	
		T26 - Implementing change management	
		T27 - Implementing knowledge management	
		T28 - Implementing service management	
	6. Implementation of information and communication technology audit	T29 - Carry out an e-government infrastructure audit	
		T30 - Carry out an e-government application audit	
		T31 - Carry out an e-government security audit	
3. Service	7. Electronic-based government administration services	L32 - Planning services	1. Information
		L33 - Budgeting services	2. Interaction
		L34 - Financial services	3. Transactions
		L35 - Services procurement of goods and services	4. Collaboration
		L36 - Staffing service	5. Optimum
		L37 - Archive services	
		L38 - Services for management of state/regional property	
		L39 - Internal oversight services	
	8. Electronic-based public services	L40 - Performance accountability services	
		L41 - Employee performance services	
		L42 - Public complaint service	
		L43 - Open data services	
		L44 - Legal documentation and information network services	
4. Use	9. Ease of use of electronic-based services	P45 - Ease of planning system	1. Very difficult
		P46 - Ease of budgeting system	2. Difficult
		P47 - Ease of financial system	3. Fairly easy
		P48 - Ease of goods and services procurement system	4. Easy 5. Very easy
		P49 - Ease of personnel system	
		P50 - Ease of filing system	
		P51 - Ease of BMN/D management system	
		P52 - Ease of internal control system	
		P53 - Ease of performance accountability system	
		P54 - Ease of employee performance system	
		P55 - Ease of public complaint system	
		P56 - Ease of open data system	
		P57 - Ease of document network system and legal information	

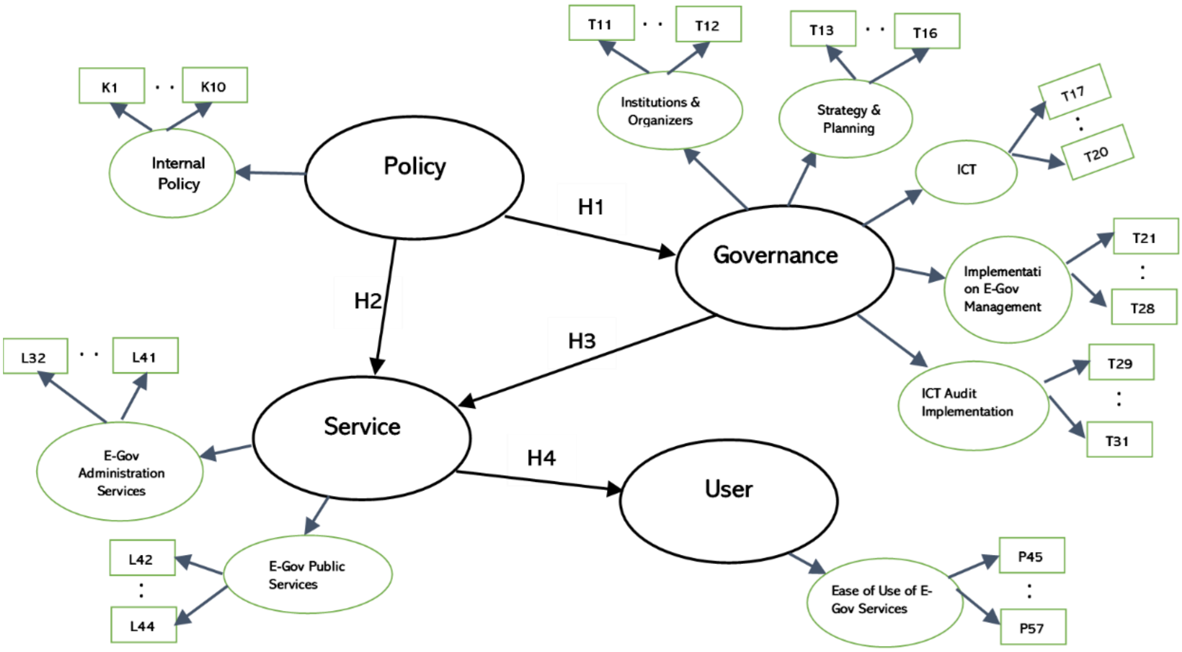

Figure 1. Measurement model concept

2. METHOD

The study employed structural equation modeling (SEM) utilizing the partial least squares (PLS) variant. The SEM-PLS analysis was performed through the stages of model conceptualization [22], evaluation, and hypothesis testing. The goal was to determine the predictive relationship between constructs using SmartPLS version 3.0.

2.1. Population and sample

This study was conducted in Gorontalo with respondents comprising government employees, including heads of departments and divisions, and e-government administrators. SEM was used to determine the item questions numbers from the latent variables, which is n×5 to n×10 [23]. Data were collected by distributing a questionnaire from August 1st to October 31st, 2022. Only 305 of 320 responses met the data processing requirements.

2.2. Data analysis

PLS with SmartPLS ver 3.0 Software was used in data analysis through the following stages:

- Evaluating the measurement or outer model by conducting: i) convergent validity, where correlation is fulfilled when the loading factor value exceeds 0.50 [24]–[26]; ii) discriminant validity is considered satisfactory when the average variance extracted (AVE) value is above 0.50 [24], [27], [28]; and iii) composite reliability, where data has cronbach alpha (CA) and composite reliability (CR) values above 0.70 [25], [29], [30].
- Evaluating the structural or inner model by assessing the R-square value (R^2) and predictive relevance (Q^2) of each variable. In this case, the R-square values of 0.67, 0.33, and 0.19 indicate a strong, moderate, and weak model, respectively [24]. The value of Q^2 higher than 0 means the model has predictive relevance [27].
- Hypothesis testing by examining the model's path coefficient and statistical significance values. The t-statistics value must exceed the t-table value while the p-value should be greater than 0.05 (t-table significance 5%=1.649).

This study determined the conceptual model [30] in Figure 1 with governance and service as the two latent variables in a multidimensional construct. The construct validity test was conducted using second-order confirmatory factor analysis [31]. Figure 2 shows the construct testing of the governance latent variable. The loading factors, CA, CR, and AVE values are presented in Tables 2 and 3.

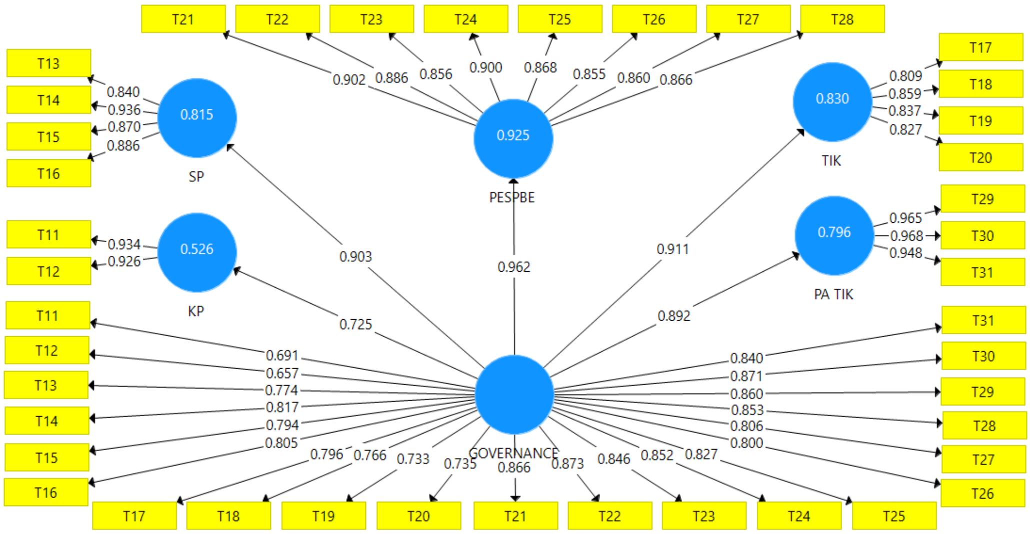

Figure 2. Governance latent variable construct

Table 2 shows that all loading factor values are significant and exceed 0.5. The lowest and highest loading factor values are 0.827 and 0.968 on the T20 and T30 indicators, respectively. Therefore, these indicators meet the convergent validity test in measuring governance variables.

Table 2. Convergent validity of governance variables

Aspect	Indicator code	Loading factor	Result
Institutions and organizers	T11	0.934	Valid
	T12	0.926	Valid
Strategy and planning	T13	0.840	Valid
	T14	0.936	Valid
	T15	0.870	Valid
	T16	0.886	Valid
ICT	T17	0.809	Valid
	T18	0.859	Valid
	T19	0.837	Valid
	T20	0.827	Valid
SPBE management implementation	T21	0.902	Valid
	T22	0.886	Valid
	T23	0.856	Valid
	T24	0.900	Valid
	T25	0.868	Valid
	T26	0.855	Valid
	T27	0.860	Valid
	T28	0.866	Valid
ICT audit implementation	T29	0.965	Valid
	T30	0.968	Valid
	T31	0.948	Valid

Table 3 illustrates that all latent variables possess both composite reliability and cronbach’s alpha values exceeding 0.7, indicating strong reliability as measurement tools. Additionally, the AVE value surpasses 0.5, indicating good convergent validity for the constructs. Therefore, the governance latent variable has achieved both validity and reliability, demonstrating a high level of measurement quality.

Table 3. CA, CR, and AVE governance latent variables

Latent variable	Cronbach’s alpha	Composite reliability	AVE
KP	0.844	0.927	0.865
SP	0.906	0.934	0.781
TIK	0.853	0.975	0.648
PE SPBE	0.956	0.963	0.764
PA TIK	0.958	0.973	0.923

Figure 3 shows the construct testing for the service latent variable. The loading factor, CA, CR, and AVE values are presented in Tables 4 and 5. Table 4 shows that all loading factor values are significant and exceed 0.5. The lowest and highest loading factor values are 0.629 and 0.924 on L36 and L43 indicators, respectively. Therefore, these indicators meet the convergent validity test in measuring the service variable.

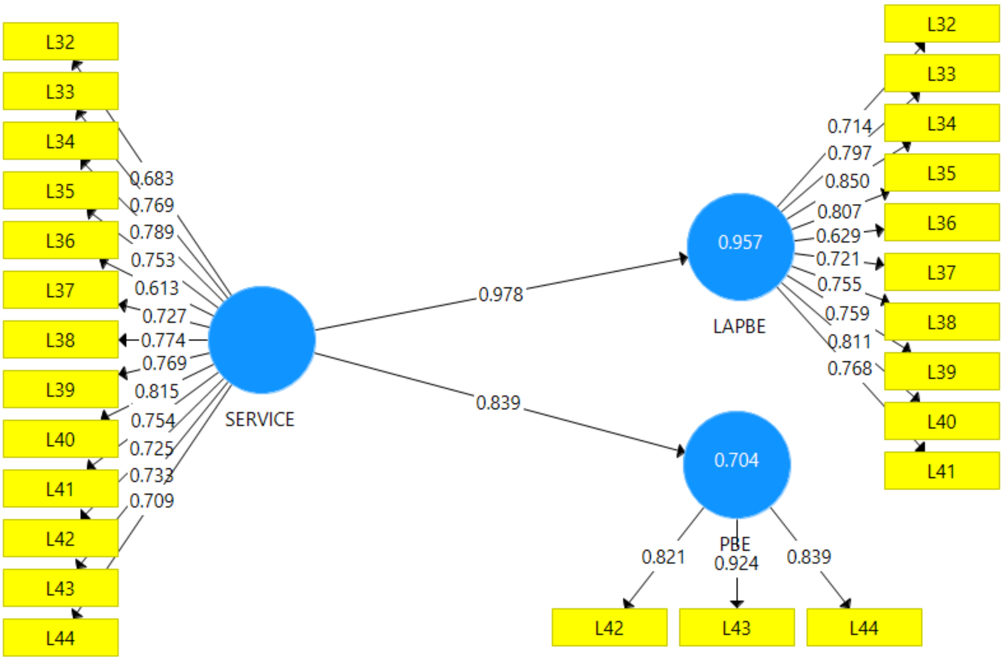

Figure 3. Service latent variable construct

Table 4. Convergent validity of service variables

Aspect	Indicator code	Loading factor	Result
Electronic-based government administration services	L32	0.714	Valid
	L33	0.797	Valid
	L34	0.850	Valid
	L35	0.807	Valid
	L36	0.629	Valid
	L37	0.721	Valid
	L38	0.755	Valid
	L39	0.759	Valid
	L40	0.811	Valid
	L41	0.768	Valid
Electronic-based public services	L42	0.821	Valid
	L43	0.924	Valid
	L44	0.839	Valid

Table 5 demonstrates that every latent variable has CR and CA values greater than 0.7. This means that all constructs have good reliability as measuring tools. The AVE value is also over 0.5, implying that the construct has good convergent validity. Therefore, the service latent variable has met validity and reliability with a good measurement level. The conceptual model changes after the governance and service latent variables meet validity and reliability. The latent variable becomes a new indicator in the conceptual construct as shown in Figure 4.

Table 5. CA, CR, and AVE service latent variables

Latent variable	Cronbach's alpha	Composite reliability	AVE
Electronic-based government administration services	0.919	0.933	0.583
Electronic-based public services	0.826	0.897	0.744

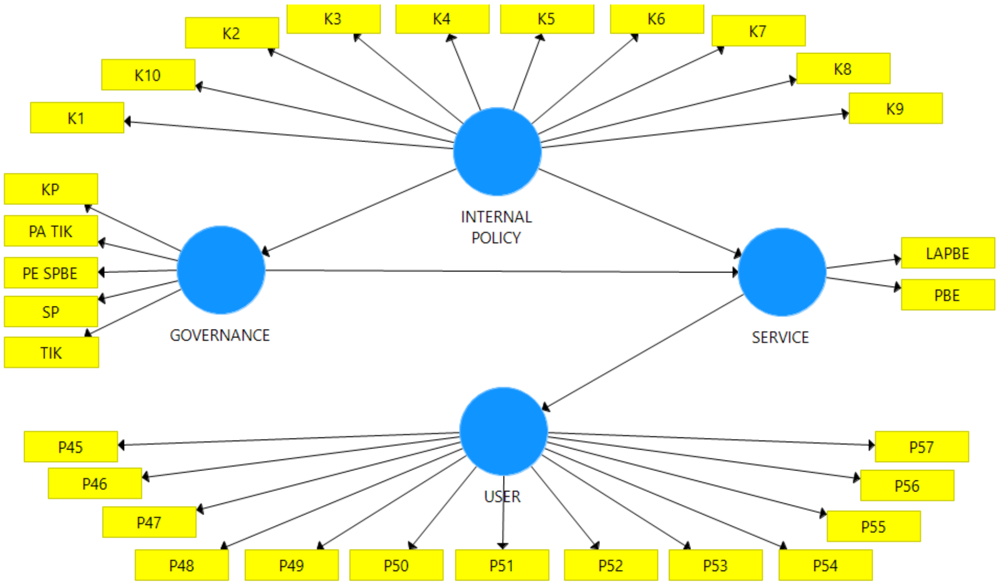

Figure 4. Conceptual model construct

3. RESULTS AND DISCUSSION

The outer and inner models were evaluated in accordance with the generated conceptual model in Figure 4. Outer model is evaluated by determining the validity and reliability. The inner model is evaluated by determining the relationship between variables and predictive relevance.

3.1. Evaluation of measurement models (outer model)

The first step in measuring the outer model was convergent validity. Figure 5 shows the relationship between parameter estimates, and Table 6 illustrates the loading factor values of each indicator variable. The correlation meets convergent validity when the loading factor exceeds 0.50. Therefore, an indicator with a loading factor value of 0.05 is removed. Table 6 shows that the loading factor values for all indicators exceed 0.5. An indicator is considered valid when the variable's outer loading factor is beyond 0.5. Therefore, all indicators for each latent variable meet the convergent validity test.

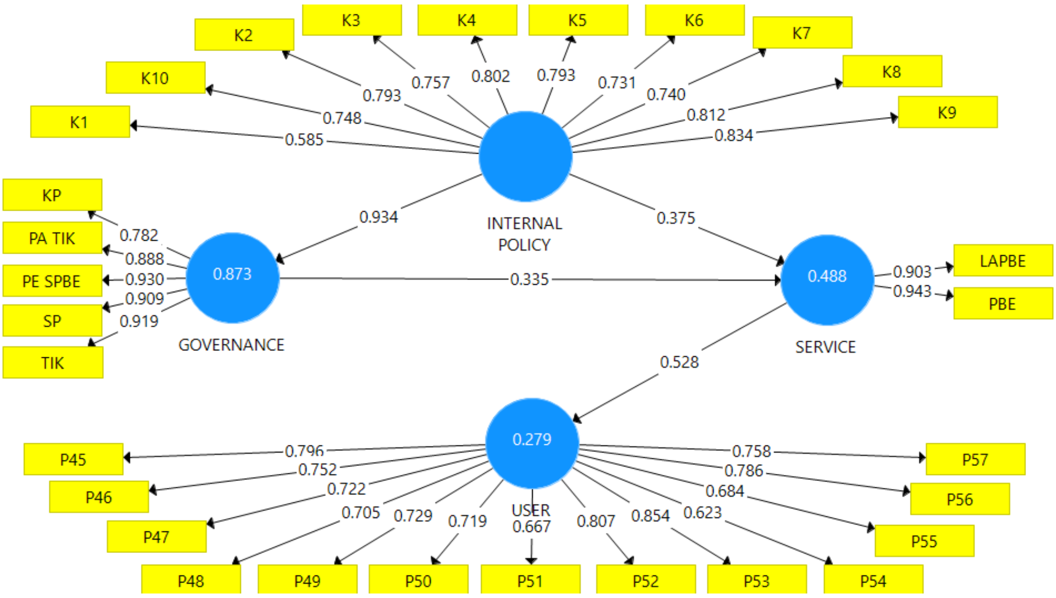

Figure 5. Parameter estimation

The discriminant validity was assessed with the provision that the AVE value should exceed 0.50. Table 7 shows that all variables obtained an AVE value greater than 0.50, meaning they meet convergent validity. A reliability test determines a latent variable's stability and consistency. A variable has good composite reliability when the value is more than 0.70 and the CA value exceeds 0.70. Table 7 exhibits that the CR and CA values of all latent variables exceed 0.70. Therefore, all variables have good reliability as measuring tools.

Table 6. Latent variable loading factors

Latent variable	Indicator code	Loading factor	T statistics	P-value
Internal policy	K_1	0.585	11.948	0.000
	K_2	0.793	27.264	0.000
	K_3	0.757	25.170	0.000
	K_4	0.802	38.924	0.000
	K_5	0.793	35.283	0.000
	K_6	0.731	28.607	0.000
	K_7	0.740	21.476	0.000
	K_8	0.812	37.566	0.000
	K_9	0.834	45.378	0.000
	K_{10}	0.748	27.450	0.000
Governance	KP	0.782	22.838	0.000
	SP	0.909	82.938	0.000
	TIK	0.919	87.936	0.000
	PE SPBE	0.930	105.745	0.000
	PA TIK	0.888	68.611	0.000
Services	LA PBE	0.903	69.419	0.000
	PBE	0.943	150.757	0.000
Use	P_{45}	0.796	35.468	0.000
	P_{46}	0.752	27.157	0.000
	P_{47}	0.722	18.891	0.000
	P_{48}	0.705	17.275	0.000
	P_{49}	0.729	21.899	0.000
	P_{50}	0.719	18.678	0.000
	P_{51}	0.667	20.049	0.000
	P_{52}	0.807	47.834	0.000
	P_{53}	0.854	49.771	0.000
	P_{54}	0.623	13.137	0.000
	P_{55}	0.684	22.844	0.000
	P_{56}	0.786	27.971	0.000
	P_{57}	0.758	27.111	0.000

Table 7. CA, CR, and AVE

Latent Variable	CA	CR	AVE
Internal Policy	0.919	0.932	0.581
Governance	0.931	0.948	0.787
Service	0.829	0.920	0.852
Use	0.931	0.940	0.549

3.2. Structural model evaluation (inner model)

The structural model was evaluated by looking at the R-square values for each endogenous latent variable, which reflect how well exogenous latent factors explain variance in endogenous variables. The findings revealed R-square values of 0.67, 0.33, and 0.19, indicating strong, moderate, and weak relationships, respectively. To further evaluate the model's predictive relevance, the Q2 values were examined. Table 8 presents the R-square values and predictive relevance (Q2). The results obtained for the R-square values suggest that all latent variables utilized in the model have a significant impact. Specifically, the governance, service, and use variables exhibit R-square values of 0.873, 0.488, and 0.279, respectively. These values correspond to strong, moderate, and weak model relationships. These findings align with the provided R-square thresholds of 0.67, 0.33, and 0.19, which indicate strong, moderate, and weak models. Furthermore, the Q2 value of 0.953, which exceeds zero, indicates that the structural model exhibits good predictive relevance. The relationship between internal policy (ξ_1), governance (η_1), service (η_2), and usage variables (η_3) in the proposed model was interpreted using three equation models as (1).

$$\eta_1 = 0{,}934\xi_1 + \zeta_1 \qquad (1)$$

In (1), it is observed that governance is influenced by the internal policy variable with a coefficient of 0.934. This indicates that a one-unit increase in the internal policy variable leads to a 0.934 unit increase in governance. The R-square value of 0.873 signifies that 87.3% of the variance in governance can be explained by the internal policy variable within this model. Consequently, the remaining 12.7% is affected by other variables not included in the current model.

$$\eta_2 = 0{,}335\eta_1 + 0{,}375\xi_1 + \zeta_2 \quad (2)$$

In (2) shows that the service variable is affected by governance and internal policy. The governance variable has an effect of 0.335, meaning that a one-unit increase in governance increases the service variable by 0.335 when internal policy remains constant. Similarly, the internal policy variable has an effect of 0.375, implying that a one-unit increase in internal policy increases the service variable by 0.375 when governance remains constant. The R-square values of the two 2 exogenous latent variables are 0.488. This means that 48.8% of services are affected by internal policy and governance. The rest 51.3% is affected by other variables outside this model.

$$\eta_3 = 0{,}528\eta_2 + \zeta_3 \quad (3)$$

In (3) shows that usage is affected by the service variable with a value of 0.528. This means that a one-unit increase in the service variable increases usage by 0.528. An R-square value of 0.279 means that 27.9% of usage is affected by the service variable. The remaining 72.1% are affected by other variables outside this model.

Table 8. R-square and Q^2

Latent variable	R-square	Q^2
Governance	0.873	
Service	0.488	0.953
Use	0.279	

3.3. Hypothesis test

Table 6 shows that the loading factor values for all indicators exceed 0.5, meaning they are valid. The path coefficient obtained is presented in Table 9. T-test criteria were used in hypothesis testing. In this case, a hypothesis was accepted when the t-statistics value exceeded the t-table with an error rate of 1.649. The following t-statistics values were obtained based on the path coefficient in Table 9.

H1 was accepted because the path coefficient obtained from the correlation between internal policy and governance is 0.934. The t-statistics value is 125.732 higher than the value of t-table of 1.649 at α=5% significance level. The p-value of 0.000 is lower than 0.05, implying that internal policies positively and significantly affect governance in the proposed model developed.

H2 was accepted because the path coefficient in the correlation between internal policy and service is 0.375. The t-statistics value is 3.268 greater than the value of t-table of 1.649 at α=5% significance level. Furthermore, the p-value of 0.001 is lower than 0.05, implying that internal policies positively and significantly affect services.

H3 was accepted since the path coefficient in the correlation between the governance variable and service is 0.335. The t-statistics value of 3.050 is higher than the value of t-table of 1.649 at a significance of α=5%. The p-value of 0.002 is also lower than 0.05, implying that governance positively and significantly affects services.

H4 was accepted because the path coefficient in the correlation between the service variable and usage is 0.528. The t-statistics value of 13.909 is higher than the value of t-table of 1.649 at a significance of α=5%. The p-value of 0.000 is lower than 0.05, implying that the service positively and significantly affects usage.

Table 9. Hypothesis test

Latent variable	Hypothesis	Path coefficient	Ts	P-value	Result
Internal policy→Governance	H1	0.934	125.732	0.000	Accepted
Internal policy→Service	H2	0.375	3.268	0.001	Accepted
Governance→Service	H3	0.335	3.050	0.002	Accepted
Service→Use	H4	0.528	13.909	0.000	Accepted

4. CONCLUSION

This study found that the model and indicators developed met the validity and reliability and could be used as measuring instruments. The structural model evaluation obtained R-square values of 0.873, 0.488, and 0.279 for the governance, service, and usage variables. This means the three variables have strong, moderate, and weak relationships, respectively. Additionally, the Q^2 value obtained was 0.953 and higher than 0, meaning the structural model has good predictive relevance. The four hypotheses proposed in this study were accepted with a positive and significant effect. Hence, the developed model effectively assesses the execution of e-government systems within the government context.

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BIOGRAPHIES OF AUTHORS

Moh Hidayat Koniyo received a bachelor of engineering degree in informatics engineering from STMIK Bandung, Bandung, Indonesia, in 1999, and a master's degree in computer science from Gadjah Mada University, Jogjakarta, Indonesia, in 2005. Currently he is pursuing a doctoral degree in Science of Engineering at the Faculty of Engineering, Udayana University. Since 2001 he has served as a lecturer at the bachelor of information systems study program, Department of Informatics Engineering, Faculty of Engineering, State University of Gorontalo, Gorontalo, Indonesia. His current research interests include IT governance, information technology, and decision support systems. He can be contacted via email: hidayat_koniyo@ung.ac.id.

Ida Ayu Dwi Giriantari is Professor in Electrical Engineering Department, born on 13 December 1965. She finished undergraduate study in Electrical Engineering Department Udayana University in 1990. Then the next year 1991, she started job as lecturer at the department where she was graduated from. In 1997 she was granted scholarship from Indonesia Government for continuing study at The University of New South Wales, Sydney, Australia. She got her Master of Engineering Science (MEngSc) form School of Electrical Engineering and Telecommunication UNSW in 1999, then under the same scholarship at the same University she obtained her Doctor of Philosophy (PhD) majoring in Electric Power in 2003. She came back to Udayana University in 2003, and in the same year she appointed as Head of Department of Electrical Engineering for the period of 2003-2007. She was one of the founders of Electrical Engineering Forum Indonesia (FORTEI) in 2005 and appointed as the Leader of FORTEI 2005-2007. She was the Head of Electrical Engineering Master Program period 2008-2016. Now, she is the Leader of CORE (Center for Community Based Renewable Energy) Udayana University. She is also member of Bali Center for Sustainable Finance (BCSF) Udayana University. She granted Academic Recharging Program from Dikti in 2009 for three months at University of Flensburg, Germany. Ida Ayu is the first Balinese who invited by US Department of State to America under International Visitor Leadership Program (IVLP) on 2-26 September 2011. As Senior Member of IEEE (Institute of Electronic and Electrical Engineering), she actives as program committee in many international conferences, and reviewer for various journals including Frontier of Energy. She is lecturing many subjects in particular: Renewable Energy, Energy Management, Energy tariff, Photovoltaic, Smart Grid, High Voltage Technology, and Electric Circuit. She can be reached via email at: dayu.giriantari@unud.ac.id.

Made Sudarma is a professor in the field of information technology in the Electrical Engineering study program, at the Faculty of Engineering, Udayana University. He completed his undergraduate education in Electrical-Computer Engineering at the Sepuluh Nopember Institute of Technology Surabaya, completed his Master of Applied Science (M.A.Sc.) at SITE-OU: School of Information Technology and Engineering, Ottawa University Canada, and completed his Doctoral program at the Udayana University Postgraduate. The courses taught are Computer Programming Concepts, Basics of Intelligent Computers, Artificial Intelligence, Software Engineering, Data Warehouse, Data Mining, Decision Support Systems, Information Retrieval, IoT, and Machine Learning. As a lecturer, he must implement the Tri Dharma of higher education, namely education, research, and community service, as well as publications that focus on Internet and Web applications, Cloud Computing, and Artificial Intelligence, contribute as a book author, and as a reviewer in international and national journals. Apart from being active in academic activities, he also works as an Information Technology consultant in local government, the private sector, and tourism. He can be contacted via email: msudarma@unud.ac.id.

Ni Made Ary Esta Dewi Wirastuti completed her B.Eng. degree in electrical engineering from Udayana University, Bali, Indonesia, in 2000. She then pursued an M.Sc. degree in mobile communication systems from the University of Surrey, Guildford, United Kingdom, in 2002. In 2007, she obtained her Ph.D. degree in Telecommunication Systems from the University of Bradford, West Yorkshire, United Kingdom. From 2007 to 2009, she worked as a Post-Doctoral Fellow at the Mobile and Satellite Communication Research Centre, University of Bradford, United Kingdom, contributing to the VeSel (Village e-Science for Life) project, which was supported by the engineering and physical sciences research council grant. In recognition of her research, she received the Best Paper Student award in 2006 from the University of Bradford for her paper presentation at INTI College, Malaysia. Her research interests primarily focus on developing physical layer models for future wireless and mobile communication systems. Since 2001, she has been serving as a lecturer in the Department of Electrical Engineering, Faculty of Engineering at Udayana University, Bali, Indonesia. For further communication, she can be contacted via email at dewi.wirastuti@unud.ac.id.